SNTHERM: 1-D Energy Balance Model for Snow and Soil

US Army Corps of Engineers®

Engineer Research and Development Center

Technology

SNTHERM (SNow THERmal Model) is a physically based snow and soil model that is forced by meteorologically determined surface fluxes. It simulates most in-snow properties and processes, such as heat conduction, water flow, melt, vapor flow, compaction, grain growth, and in-depth solar absorption. As output, it provides snow depth, profiles of snow temperature, water content, density, grain size, and surface fluxes of sensible heat and evaporation. Optionally, it computes fluxes of solar and longwave radiation and albedo. The underlying soil component contains only a thermal equation, and thus models temperature profiles and frost depth, but not water or vapor flow. Any number of user-supplied soil strata or material types are permitted. The code has been publicly available for several years and is widely used both in the United States and abroad by government agencies, universities, and private industry.

SNTHERM is written in FORTRAN 77 and runs on UNIX and PC-based platforms.
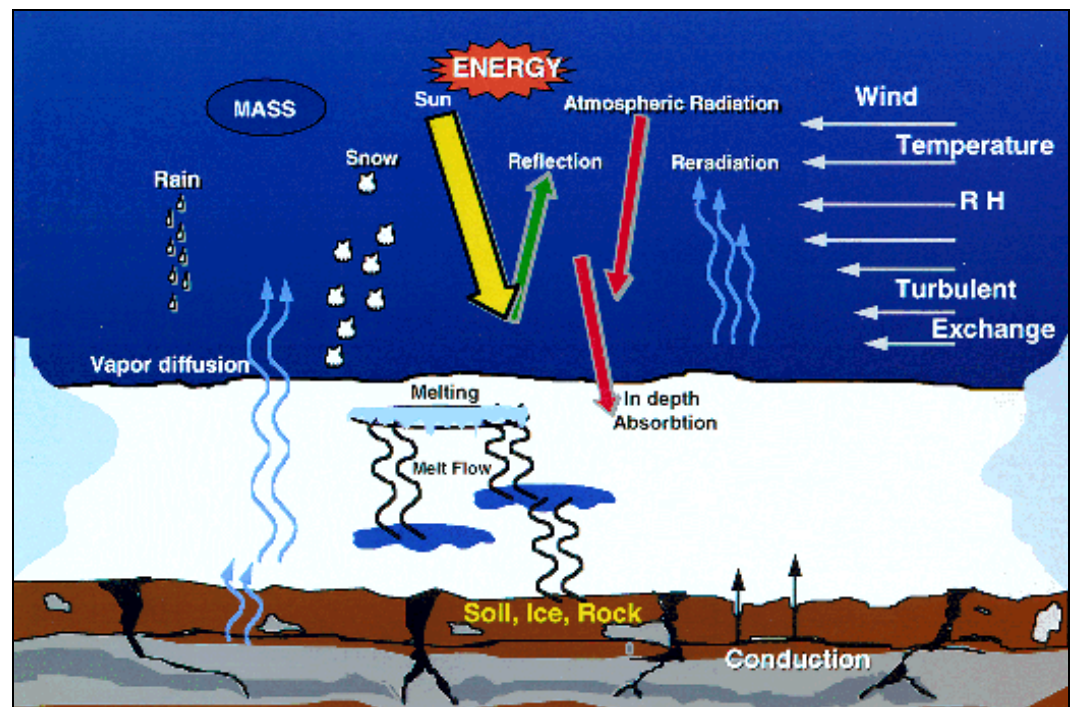
Snowpack Energy Balance.

Problem

Flooding from snowmelt in mountainous areas worldwide is a concern. Trees and cloud cover make it impossible to see or accurately measure snow cover. Using SNTHERM model simulations in conjunction with satellite imagery, scientists can accurately predict snowmelt in even the most remote locations, providing a valuable public service.

Expected Cost To Implement

SNTHERM is free.

Benefits/Savings   SNTHERM is validated, flexible, and easy to use. It has been used by military and civil programs and has been exercised over a range of global latitudes that experience winter conditions.

It has been used by USACE combat engineers in Bosnia to predict high water marks to aid in the planning of bridge construction projects, and has been used by global climate change researchers to measure the melt rate of the polar ice caps.

The U.S. Department of Transportation is testing SNTHERM for road icing hazard, and SNTHERM has further potential for predicting state-of-the-ground effects on traffic mobility, winter construction, and seismic/acoustic wave propagation.

Status   An upgrade (SNTHERM04) to the original code released in 1989 is being developed.

Planned changes include a revised turbulent transfer algorithm, inclusion of sea ice as a substrate option, advection and compaction of blowing snow, inclusion of organic matter in soil and forest litter in snow, expanded options for computing thermal conductivity, heat transfer within pavements, and additional output files.

SNTHERM04 is being developed to work both as an operational and research grade model. It is intended to undergo continual development; suggestions for upgrading the code are welcome. Many of the new options are intended as aids to the snow researcher.

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Distribution Sources   Procedure for obtaining the code via ftp:

- ftp.crrel.usace.army.mil
- Log in with user name "anonymous."
- Use any password with at least three characters.
- cd pub/outgoing/SPECIAL/sntherm89.
- dir
- bin (to ensure that files are transferred in binary mode)
- Get or mget all files in the directory.

Available Documentation   Documentation is available at http://snow.usace.army.mil/model_info/sntherm.html.

Available Training   Training is not available.

Available Support   If you have technical questions or problems implementing the code, please contact Dr. Susan Frankenstein. If you have difficulty connecting to the ftp site, please contact Linda Gee and copy Dr. Frankenstein.